Natural Image Quality Assessment Based on Visual Biological Cognitive Mechanism

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ABSTRACT

With the focus of the main problems in no-reference natural image quality assessment (NR-IQA), the researchers propose a more universal, efficient and integrated resolution based on visual biological cognitive mechanism. First, the authors bring up an inspiring visual cognitive computing model (IVCCM) on the basis of visual heuristic principles. Second, the authors put forward an asymmetric generalized gaussian mixture distribution model (AGGMD), and the model can describe the probability distribution density of the images more precisely. Third, the authors extract the quality-aware multiscale local invariant features (QAMLIF) statistic and perceptive from natural images and form quality-aware uniform features descriptors (QAUFD) based on clustering and encoding the visual quality features. Fourth, the authors build topic semantic model and realize the resolution with Bayesian inference with IVCCM, AGGDM and QAUFD to implement NR-IQA. Theoretical research and experimental results show that the proposed resolution perform better with biological cognitive mechanism.

KEYWORDS

Asymmetric Generalized Gaussian Mixture Distribution, Bayesian Inference, Features Descriptor, NR-IQA, Topic Semantic Model, Ventral Visual Pathway, Visual Cognitive Model, Visual Heuristic Principles

1. INTRODUCTION

The authors propose a more general-purpose, effective and integrated resolution to implement NR-IQA based on visual biologically cognitive mechanism, including a inspiring visual cognitive computing model (IVCCM) on the basis of visual heuristic principles, an asymmetric generalized Gaussian mixture distribution model (AGGMD), the quality-aware multiscale local invariant features (QAMLIF) and quality-aware uniform features descriptors (QAUFD), topic semantic model, and then the authors realize the resolution with Bayesian inference with IVCCM, AGGDM and QAUFD to implement NR-IQA, which perform better with theoretical research and experimental results.

1.1. Background

Images are visual basis that people can apperceive the real world. It is an effective way in which human beings can achieve, express and communicate information each other. With the development of images processing technology and visual cognitive scientific theory, much more progress has been made in NR-IQA applications. (Venkatanath,2015) put forward a novel no-reference perception-

based images quality evaluator (PIQUE) algorithm on the basis of extracting local features just in spatial domain, imitated human behavior, and employed multivariate Gaussian model (MGM) as probability distribution function (PDF) of natural images features. (Zhao, 2015) proposed an efficient general-purpose blind/no reference image quality assessment (NR-IQA) algorithm with frequency domain features of phase congruency values and local spectral entropy values. In the inspired by inspired by the sparse representation of visual scenes in the primary visual cortex of the human visual system (HVS), (Priya,2016) presented a no reference image quality assessment (NR-IQA) method. (Plataniotis, 2016) put forward parametric models in which described the universal features of chromatic data from natural images, and computed the correlation of chromatic characteristics like hue, saturation, opponent angle and spherical angle between spatially adjacent pixels with the help of color invariance descriptors, and so on. All the algorithm played an advantageous role in images quality assessment with no reference.

1.2. Main Focus of the Article

But, above-mentioned assessment methods had some serious problems summarized as follows:

1. Visual information of HVS processing mechanism and properties are far from understanding and appliance;
2. The model of the probability distribution function(PDF) for natural images is not more accurate;
3. There is a gap between visual quality-aware features of natural images and semantic quality of these;
4. The resolution, general-purpose, efficient and integrated, is not ideal for NR-IQA.

The literature (Venkatanath, 2015) just used natural images statistics features without HVS mechanism, model and applications. (Zhao, 2015) did not consider the probability distribution function of images and employ the visual characteristics too. (Priya, 2016) put forward a kind of algorithm which was inspired only by the primary visual cortex (V1) without any other visual cortexes of HVS. (Plataniotis, 2016) only calculated the color relevance to visual features and did not extract any other quality-aware features (QAF).

Aiming at the main existing problems in no-reference natural image quality assessment (NR-IQA), the researchers propose a more general-purpose, efficient and integrated resolution based on visual biologically cognitive mechanism after studying the domain deeply.

The researchers organize the rest of the paper as follows: Section 2 mainly studies the proposed inspiring visual cognitive computing model (IVCCM) based on the visual heuristic principles proposed below. Section 3 principally refer to the proposed asymmetric generalized Gaussian mixture distribution model (AGGDM) used to describe the probability distribution function of images. Section 4 mainly discussed the quality-aware multiscale local invariant features extracted and quality-aware uniform features descriptors represented from natural images. The authors implement the proposed NR-IQA resolution based on IVCCM and AGGDM in section 5. Finally, the authors draw some conclusions and discuss the future work to improve the method.

2. INSPIRING VISUAL COGNITIVE COMPUTING MODEL

After years and years of evolution, HVS has been turned into a complex, intelligent image processing system with high efficiency and low consumption. The authors study the visual cognitive theory, computational neuroscience fundamentals and research result, propose the highly concise visual heuristic principles, on the basis of which the researchers further put forward an inspiring visual cognitive computing model (IVCCM), which lays a solid foundation to the whole NR-IQA resolution.

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